Weak Gravitational Lensing in GOODS

Overview

Alongside neutrino and electromagnetic radiation observation, gravity stands as an independent probe of the cosmos. Gravitational lensing in particular, since it arises solely from spacetime curvature, is maturing as a viable means of mapping baryonic and dark matter in the sky. Theorists have shown that gravitational lensing's weakest regime probes structure on the largest known scales—those of galaxy superclusters. Their theories allow physicists to directly measure, for example, the cosmological parameter σ_8, which normalizes the power spectrum of mass density perturbation within an eight megaparsec sphere.

Modern technology allows for this new kind of measurement. Weak lensing analysis requires accurate images of many distant galaxies, and the Great Observatories Origins Deep Survey (GOODS) fulfills these requirements. The GOODS collaboration, which, in part, utilizes the Hubble Space Telescope, has produced images that resolve galaxies up to a redshift of about six.

By analyzing the weak gravitational lensing in GOODS, what is the mass power spectrum? Does this observed power spectrum determine or bound σ_8? My honors senior thesis will answer these questions, and in the process I will generate various maps of the GOODS fields, including shear and convergence, curl and divergence of the shear, and perhaps the point-spread functions (PSF) of the apertures. Systematic error such as anisotropic PSF poses the greatest challenge to this research since it easily threatens weak lensing signals, which manifest as a less than ten percent shear in an image. I will explore the methods proposed by astrophysicists such as Kaiser, Squires, and Broadhurst (1995); Rhodes, Refregier, and Groth (2000); and Refregier and Bacon (2003).

Non-departmental advisors

Jodi Lamoureux, scientific staff with Professor George Smoot's observational astrophysics research group at the Lawrence Berkeley National Laboratory (LBNL), guides me on my project. She now works on gravitational lensing computer algorithms and models for the planned Supernova Acceleration Probe, and provides me with seasoned and highly relevant expertise. She also takes an interest in and has experience working with undergraduate physicists.

Space and Time Constraints

I first engaged in this project through the Undergraduate Research Apprentice Program at the start of the fall 2003 semester. I discovered that, given the constraints of my course schedule, I can allot about nine hours of in-lab work per week comfortably. I can also work from home, especially on weekends, and I plan to work on it full time over the summer. Although I have already begun the work, my thesis project officially begins this spring semester with this proposal. That gives me until December to complete the research and the paper.

To reach this deadline, Professor Smoot's research group provides me with ample resources. The project is computing intensive, so the group gives me a workstation at LBNL with a desktop computer equipped with standard scientific computing tools. I can also access these computers from my personal computer. Additionally, they allow me access to the Parallel Distributed Supercomputing Facility, based at LBNL, for particularly intensive tasks.